SANWA

OPERATOR'S MANUAL

FOR

SP-6D

MULTITESTER

SP-6D Multitester

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GENERAL DESCRIPTION

1. Introduction.

Built of choice materials and for its dependable performance, the **SP-6D** Multitester assures you of unfailing electrical engineering service.

Functional design of the **SP-6D** renders it a standard pocket-size circuit tester of rotary switching system containing the following features:

a. The meter movement is doubly protected from damage. The protection circuit electrically safeguards the movement against accidental overcurrent, and mechanically the moving element is supported by spring-backed jewel bearings to absorb shock.

b. The low resistance range measures 0.2 ohm at minimum.

c. The wide scale dial admits full light for easy reading.

d. Ranges are readily selected by a single-control rotary switch.

e. The battery sheaths eliminate reading error for all types of cells, magnetic or nonmagnetic armoured.

An electric circuit tester is a precision instrument. To avoid misuse, read this booklet carefully before you operate your meter.

2. Specifications.

a. Measurement Ranges.

DC voltage:	10V	50V	250V	500V	1000V (2k Ω/V)
AC voltage:	10V	50V	250V	500V	1000V (2k Ω/V)
DC current:	0.5mA	25mA	500mA		
Resistance:	Range	Ω×1	Ω×10	KΩ	
	Midscale	20Ω	200Ω	10kΩ	
	Maximum	500Ω	5kΩ	1MΩ	
	Minimum	0.2Ω	2Ω	200Ω	
Volume level:	−20～+22dB & +20～+36dB				
*Capacity:	0.0001～0.03μF & 0.01～0.6μF				
*Inductance:	10～1000H				
*High resistance:	0.1～50MΩ			*Use external power.	

b. Batteries. Two 1.5 volt dry cells (UM-3 or equivalent).

c. Size & weight. 132×95×40mm & 435 gr

d. Allowance.

DC voltage & current:	Within	±3%	at full scale deflection
AC voltage:	〃	±4%	at full scale deflection
Resistance:	〃	±3%	of scale length

GENERAL MAINTENANCE

1. Before applying the test leads to a circuit, always confirm the range to be used. Misapplication of an ohm or current range for a voltage measurement will burn a shunt, resistor or the rectifier rendering the meter out of use.

2. For accurate measurements of voltage and current, choose a range which will allow the pointer to fall within the right hand half of the scale. For instance, 1.5 and 9 volt batteries should be checked on the DC 10 volt range, while the power distribution line of 220 volts, on the AC 250 volt range. Less accurate are the readings on the left hand half.

3. When checking an unknown voltage or current, always start with the highest range to safeguard the meter movement from getting overloaded. After the first reading, the switch can be reset to a lower range for a more accurate reading.

4. When rotating the switch for voltage or current measurement, disconnect either of the test leads. If the switch is turned while the power is on, the meter movement can be damaged.

5. Do not give the meter severe vibration or shock. Avoid placing it in the direct sun or where there is high temperature or moisture.

METER MOVEMENT PROTECTION

The meter movement of the **SP-6D** is protected from high voltage when any measurement range is accidentally loaded with a voltage below 1000 volts only by having some resistor or the rectifier suffer burning. Their replacement restores the meter to its normal performance. The following table shows the resistors to be burnt on account of a high voltage impressed on each range:

Meter range	Resistor to burn	Part No.
Ω× 1	19.5Ω	R13
Ω×10	208Ω	R12
KΩ	5KΩ, 4.3KΩ	R11, R10
0.5mA DC	1.1KΩ, 21.3Ω	R7, R8
25mA DC	21.3Ω	R8
500mA DC	1.12Ω	R9
10V DC	19.3KΩ	R5
10V AC	18.5KΩ	R6

OPERATION

1. Zero Correction

Before the meter is put to use, confirm if the pointer is exactly over zero of the scale. If it is off the position, adjust it by turning the corrector screw on the base of the scale window.

2. Selecting the Range.

Ranges are selected by rotating the selector switch knob. Around the knob are arranged resistance ranges on the top, AC voltage ranges on the right (red), DC voltage ranges on the left and DC current ranges on the bottom.

3. Test Lead Connections.

As a rule, the red lead is connected to the (+) and the black lead to the (−) jack. Insert them well down.

4. DC Voltage Measurements.

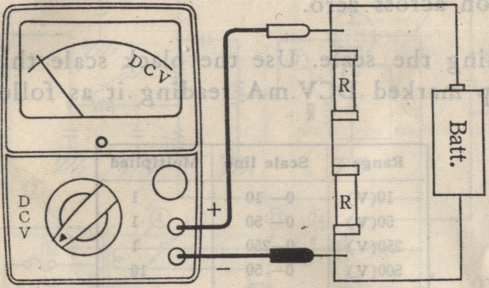


Fig. 1 - DC Voltage Measurement.

a. DC voltage ranges are mostly used for measurements of batteries, B (+) power, plate, screen-grid and cathode voltages of radio and TV sets and amplifiers.

b. The selector switch is rotated to any one of the 5 DCV positions.

c. Voltage is measured in parallel with the load. Taking note of the polarities of the voltage to be measured, the red lead is applied to the positive side

of the circuit and the black lead to the negative side. Wrong connections deflect the pointer to the reverse direction across zero.

d. Reading the scale. Use the black scale third from the top marked DCV.mA reading it as follows:

Range	Scale line	Multiplied
10(V)	0— 10	1
50(V)	0— 50	1
250(V)	0—250	1
500(V)	0— 50	10
1000(V)	0— 10	100

In these circuits, the minus side of the voltage is generally earthed or connected to the chassis. When checking them, the black lead may be fixed to the chassis or the earth line, and the voltage is checked by the red lead.

For pnp transistor circuits, plus side is earthed, and the connections of the test leads are reversed.

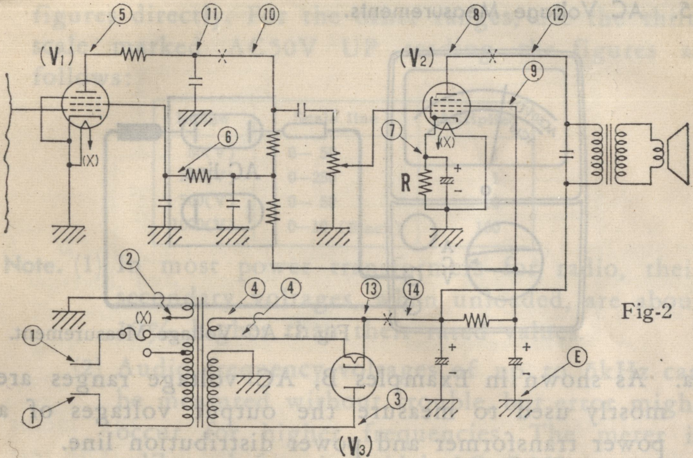


Fig-2

Examples A. (See Fig. 2)

Voltage of:	Red lead-Black lead	Meter range
Plate of detector tube (V1)	5 — E	DC 250V
Screen-grid of detector tube	6 — E	DC 250V
Grid bias of power tube (V2)	7 — E	DC 50V
Plate of power tube	8 — 7	DC 250V or 500V
Screen-grid of power tube	9 — 7	DC 250V

5. AC Voltage Measurements.

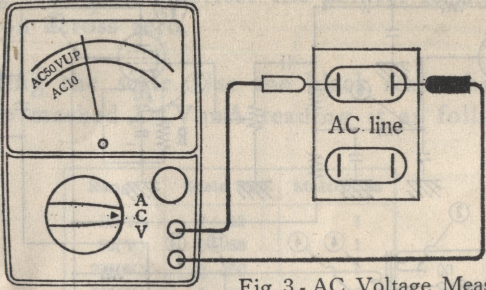


Fig. 3 - AC Voltage Measurement.

a. As shown in Examples B, AC voltage ranges are mostly used to measure the output voltages of a power transformer and power distribution line.

b. The connections of the test leads are same as for DC voltage measurements, i.e., in parallel with the power. Since alternating current is being measured, readings are correct to which side of the voltage the test leads are connected.

c. Reading the scale. For the AC 10 volt range alone, use the red scale fourth from the top reading the

figures directly. For the other ranges, use the third scale marked AC50V UP reading the figures as follows:

Range	Scale line	Multiplied
50(V)	0— 50	1
250(V)	0—250	1
500(V)	0— 50	10
1000(V)	0—10 (Black)	100

Note. (1) In most power transformers for radio, their secondary voltages, when unloaded, are about 10% higher than their rated values.

(2) Audio frequency voltages of up to 5kHz can be measured without trouble, but error might occur for higher frequencies. The meter is calibrated for sinusoidal AC (RMS), so error will also occur for non-sinusoidal voltages.

Examples B. (See Fig. 2)

Voltage of:	Red lead · Black lead	Meter range
Power distribution line	1 — 1	AC 250V
Heater of rectifier tube (Vs)	4 — 4	AC 10V
Heater except rectifier tube	2 — E	AC 10V
B(+) of power transformer	3 — E	AC 250V or 500V

6. DC Current Measurements.

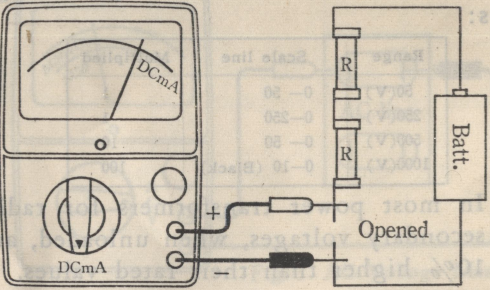


Fig. 4 - DC Current Measurement.

a. Different from voltage measuremeents, the meter must be connected in series with the load. The test point (× in Fig. 1) is opened and the meter is placed in between by way of the test leads.

b. As in DC voltage measurements, take note of the polarities of the check point for the test lead connections.

c. Reading the scale. Use the black scale third from

the top in common with DC voltage measurements, reading the figures as follows:

Range	Scale line	Multiplied
0.5(mA)	0—50	0.01
25(mA)	0—250	0.1
500(mA)	0—50	10

d. When the circuit resistance is known, it need not be opened, but the current on R is known by dividing the voltage between 7 and E by R figures (Ohm's Law). This is more efficient and practical.

Examples C. (See Fig. 2)

Voltage of:	Red lead-Black lead	Meter range
Plate of detector tube (V_1)	10 — 11	DC 25mA
Plate of power tube (V_2)	12 — 8	DC 500mA
B(+)	13 — 14	DC 500mA

7. Internal Resistance of Voltage Ranges.

Voltage is measured, applying the test leads in parallel with the load. Current energy (current consumption of a voltmeter) can cause the pointer to give an erroneous reading.

Current consumption of a meter is inversely proportional to its internal resistance: the bigger the resistance, the less the current consumption, and consequently the more efficiently the meter functions.

As a rule, the internal resistance of a voltmeter is expressed by the resistance per volt using the symbol of Ω/V. Therefore, the internal resistance of a certain voltage range is known by the voltage value multiplied by the Ω/V of the meter. The overall internal resistance of the **SP-6D** being 2000 ohms pet volt for both DC and AC, that of the 500 volt range is $500 \times 2000 = 1{,}000{,}000$ (Ω), or 1 megohm.

When the plate or screen-grid voltage of a triode or pentode of high impedance load and high amplification factor along with small circuit current is checked by a meter of small internal resistance, considerable current

flows from the meter into the series load resistance of the tube. As a consequence, there is a greater voltage drop and the meter reads lower than the true value: the connection of the meter upsets the circuit being checked. The error can be minimized by the use of a meter of high internal resistance, but unless it is infinite, some error is inevitable even if a valve voltmeter be used for checking such a circuit.

The internal resistance of a meter has little effect when checking the DC voltage of B(+) power or plate and screen-grid of a power tube because their impedances are smaller than the meter impedance: it is the control grid voltage that is disturbed by voltage measurement.

The internal resistance of a voltage range, is proportionately bigger for higher voltages and readings are naturally higher on them. On the other hand, the pointer tends more towards left on account of the decreased current, and less accurate are the readings. In consideration of it, the voltage values of radio and TV sets are usually given specifying the internal resistance of the meter and its voltage ranges to be used for their measurements.

8. Resistance Measurements.

a. The selector switch can be rotated to any one of the 3 resistance ranges.

$\Omega \times 1$ is for measurements of 0-50 ohms, $\Omega \times 10$ for 50-2k ohms, and KΩ for 2k-1M ohms.

For an accurate measurement, use a range which will allow the pointer to fall near the middle of the ohm scale.

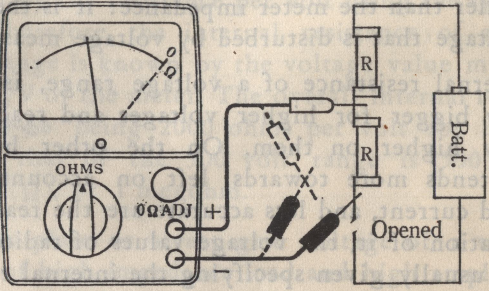


Fig. 5 - Resistance Measurement.
(Zero ohm adjustment)

b. For the test lead connections, use the two jacks, (+) for the red lead and (−) for the black lead.

c. Zero adjustment. Before taking a measurement, the test leads connected to the meter are shorted together. (Fig. 4, dotted line)

As the pointer deflects towards right, it is adjusted to be exactly on zero of the ohm scale by slowly rotating the 0Ω ADJ knob. Do not force it beyond its stop position.

The zero ohm adjustment is to avoid reading error caused by the wearing out of the internal batteries or change of the load current. The pointer must be adjusted from time to time when resistances are checked. It must also be adjusted as the switch is moved to each range.

If zero adjustment is impossible when the adjusting knob is turned full clockwise, or if the pointer moves to zero but soon moves back on $\Omega \times 1$ range, the internal batteries are exhausted and they must be replaced immediately.

Sometimes both the two batteries need not be replaced at a time, because, when a certain resistance is checked for a same lapse of time, the current consumed differs according to the range used, most on the $\Omega \times 1$ range and least on the $K\Omega$ range. The load current when the test leads are shorted together for zero ohm adjustment is abut 75mA for the $\Omega \times 1$ range, 7.5mA for the $\Omega \times 10$ range and 0.3mA for the $K\Omega$ range. Therefore, the $\Omega \times 1$ range should be used for measurement of low resistances, while continuity should be checked on the $K\Omega$ range.

To know if B1 alone needs replacement or both B1 and B2, change B1 with B2 and adjust zero ohm. If adjustment is impossible, both B1 and B2 must be replaced. See SUPPLEMENTARY CHARTS, 2 Arrangement of Parts.

d. Replacement of the batteries. Remove the rear case by loosening the bolt and put the meter face down on a soft cloth. Loosen the fixing bolt on the minus side and pull out the sheathed battery and push it out.

After the batteries are replaced, do not tighten the bolts too much, or the battery mount will be cracked. If iron-armoured cells are used without sheath, reading will be lower than the true value on account of the magnetic effect. The battery sheath is to eliminate this reading error for any type of cells. Unsheathed batteries will cause positive error.

e. As the zero ohm position is adjusted properly, the test leads are opened and are applied across the resistance to be measured.

f. Reading the scale. Use the top black scales for all resistance measurements.

For the $\Omega \times 1$ range, use the lower scale reading the figures directly. For the $\Omega \times 10$ range, read the figures multiplied by 10.

For the $K\Omega$ range, use the upper scale reading the figures directly in $K\Omega$.

Note. (1) When checking a resistance, keep off the

fingers from the metal parts of the test leads; part of the current runs to the ground through the body causing erroneous reading.

(2) Do not check resistance while power is on. Be sure the condenser current is discharged in a radio circuit.

(3) Exhausted batteries must be immediately replaced. Electrolyte might leak and corrode the internal components. Batteries had better be taken out when the meter is stored unused.

(4) As the schematic diagram shows, the polarities of the measuring jacks are reversed for the resistance range, the plus terminal being in minus and the minus terminal in plus potential. It must be remembered when checking semiconductors.

9. Volume Level Measuremenrs.

a. Audio output of a radio set and amplifier where both AC and DC currents are present is checked on an AC voltage range by placing a nonpolarized condenser of 0.1 to 2 microfarads in series with a meter terminal to block DC component. This is called AF (audio frequency) output measurement.

b. On the other hand, what matters to an amplifier and transmission circuits is their input-output power ratio, which is gain (amplification) or loss (attenuation) of the circuit. Comparative readings by voltage, current or power would be annoying for the odd figures to be obtained by calculation, while the response of the human ear is analogous to logarithmic variation, their ratios are usually expressed by logarithm using decibel unit. Though a meter does not measure power level directly, if the line impedance on both input and output sides is 600 ohms, gain or loss can readily be known by the output decibel minus input decibel. But, if the impedance is other than 600 ohms on one side or on both sides, each decibel measured only

serves to compare their voltage levels.

c. As a rule, zero decibel is set at a voltage when 0.001 watt is dissipated across a 600-ohm line, and zero reference level is established at approximately 0.775 volt. The decibel scales of the **SP-6D**, are graduated based on this reference to read from −20 up to +36 decibels on the AC 10 and 50 volt ranges.

d. To measure decibel, the selector switch is rotated to the AC 10 volt range, and the test leads connected to the meter by way of the blocking condenser (See-9-a) are applied across the 600-ohm line to be checked.

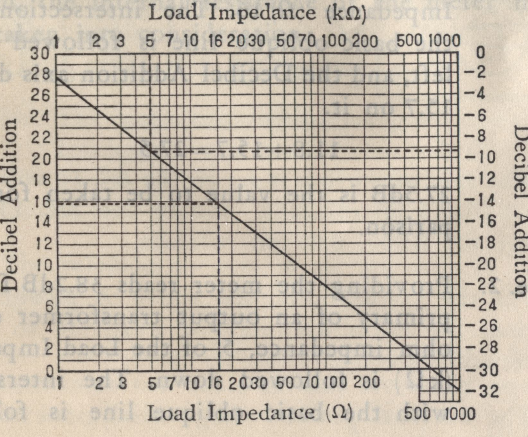
e. Reading the scale. The bottom black scale is for decibel measurements. Read the upper figures for the AC 10 volt range.

A big output deflects the pointer across AC 10 volt reading, when the switch is moved up to the 50 volt range and the lower figures are read.

For a still bigger output, use higher ranges. Depen-

ding on the range used, the following figures are added to the maximum reading on the 50V range:

Range used	Add
AC 250V	14dB
AC 500V	20dB
AC 1000V	26dB



f. Line impedance other than 600 ohms can be matched to a 600-ohm line by reading the graph given below.

To the decibel measured on the meter is added to or subtracted from it the dB obtained from the graph.

Example 1. Providing the meter reads 11.8 dB on the AC 10 volt range for a speaker voice-coil impedance of 16Ω, follow up the Load Impedance (Ω) 16. The intersection with the basic oblique line is followed to the left, and the Decibel Addition axis denotes 15.7 on it.

$$11.8 + 15.7 = 27.5$$

27.5dB is the value to be taken for comparison.

Example. 2. Providing the meter reads 38.2dB for the primary of an output transformer of 5k-ohm impedance, 5 of the Load Impedance (kΩ) is followed down. The intersection with the basic oblique line is followed

to the right, and the Decibel Addition axis denotes 9.2.

$$38.2-9.2=29$$

29dB is the value to be taken for comparison.

Loss from connecting the meter to a 600-ohm line is negligible, but when a high impedance circuit is checked, the internal resistance of the meter must be fully taken into consideration.

10. Capacity, Inductance and High Resistance Measurements.

a. Capacity.

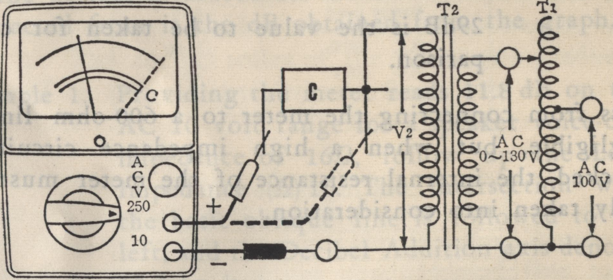


Fig. 7 - Capacity measurement.

(1) The selector switch is set to the AC 10 volt range for 0.01-0.6 microfarads, and to the AC 250 volt range for 0.0001-0.03 microfarads.

(2) For the connections, see above A power transformer for radio use may be available to obtain external power.

(3) The external power voltage is adjusted to 10 or

250 volts full scale by means of a voltage regulator as shown by the dotted line. The regulator should be started from the lowest range not to overload the meter.

(4) The condenser to be checked is connected in series and the meter reading is noted. Be sure to switch off the power before connecting the condenser.

(5) Use the scales marked C(μF). For the AC 10 volt range, read the lower scale, and for the AC 250 volt range, the upper scale.

Note. The static capacity of polarized (electrolytic) condensers can not be checked.

b. Inductance.

(1) The selector switch is set to the AC 10 volt range.

(2) For the connections, see next page. A power transformer for radio is also available to obtain external power.

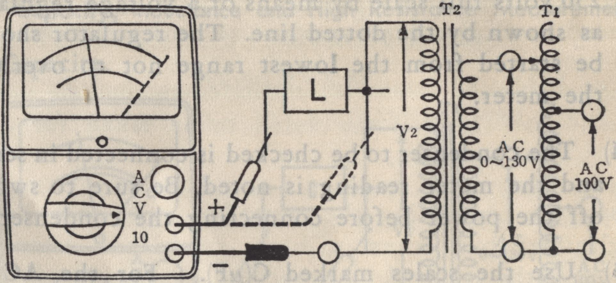


Fig. 8 - Inductance measurement.

(3) The external power voltage is adjusted to read 10 volts at full scale by means of a voltage regulator as shown by the dotted line. Start the regulator from the lowest position so that the meter may not be overloaded.

(4) The coil to be checked is connected in series and the meter reading is noted. Switch off the power before connecting the coil.

(5) Use the black scale marked L(H).

c. High Resistance.

(1) The range switch is set to the DC 250 volt range.

(2) For the connections, see next page. The B(+) power of a radio set is available to obtain external power.

(3) The external power voltage is adjusted to 250 volts full scale by means of a variable resistor (VR). When adjusting, be very careful not to overload the meter.

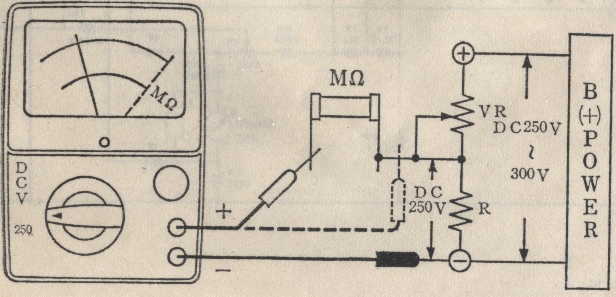


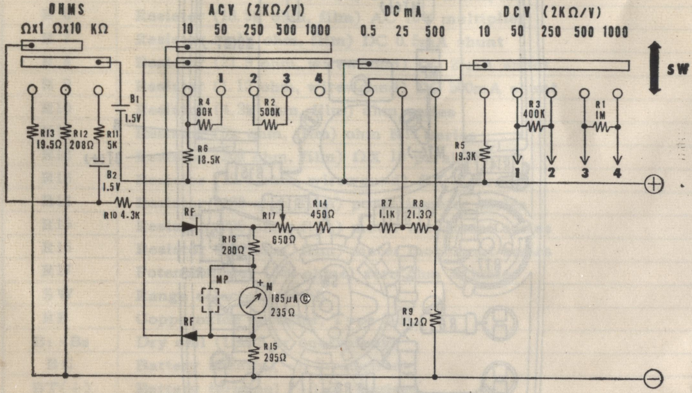
Fig. 9 - High Resistance measurement.

(4) A high resistance (megohm) to be checked is connected in series and the meter reading is noted. Switch off the power before connecting the resistance.

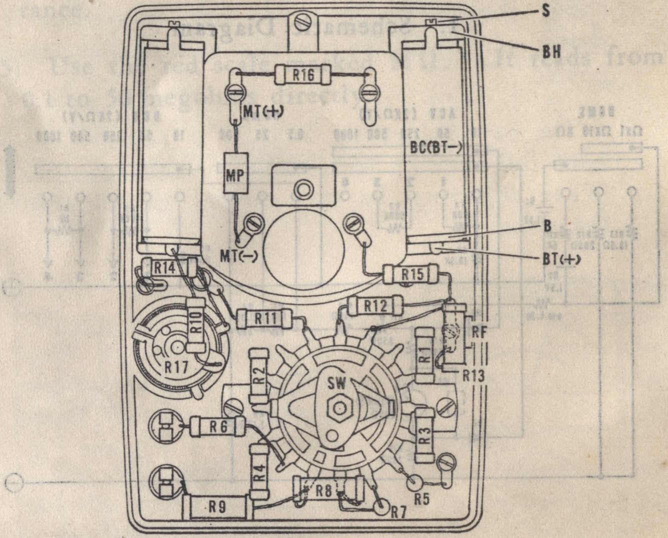
(5) Use the red scale marked MΩ. It reads from 0.1 to 50 megohms directly.

SUPPLEMENTARY DATA

1. Schematic Diagram



2. Arrangement of Parts (Rear View)



3. List of Main Parts

Part No.	Description
R 1	Resistor (1M ohm, film) DC, AD 1000V multiplier
R 2	Resistor (500k ohm, film) DC, AC 500V multiplier
R 3	Resistor (400k ohm, film) DC, AC 250V multiplier
R 4	Resistor (80k ohm, film) DC, AC 50V multiplier
R 5	Resistor (19.3k ohm, film) DC 10V muitiplier
R 6	Resistor (18.5k ohm, film) AC 10V multiplier
R 7	Resistor (1.1k ohm, film) DC 0.5mA shunt
R 8	Resistor (21.3 ohm, wirewound) DC 25mA shunt
R 9	Resister (1.12 ohm, wirewound) DC 500mA shunt
R10	Resistor (4.3k ohm, film) ohm series
R11	Resistor (5k ohm, film) ohm KΩ series
R12	Resistor (208 ohm, film) ΩX 10 parallel
R13	Resistor (19.5 ohm, wirewound) ΩX 1 parallel
R14	Resistor (450 ohm, film) potentiometer series
R15	Resistor (295 ohm, film) meter movement series
R16	Resistor (280 ohm, film) meter movement series
R17	Potentiometer (650 ohms) zero ohm adjuster
SW	Range selector switch
RF	Copperoxide rectifier, Type 20B
$B_1 \cdot B_2$	Dry cell (UM-3 or equivalent)
BC	Battery sheath (−), 2 required
BT(+)	Battery terminal (+), 2 required
M	Meter movement (185μA 235Ω) moving coil type
MT(−)	Meter movement terminal (−), 3 required
MT(+)	Meter movement terminal (+)
S	Battery fixing bolts, 2 required
MP	Meter movement overload protection

5,000-11-70

NOTE

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